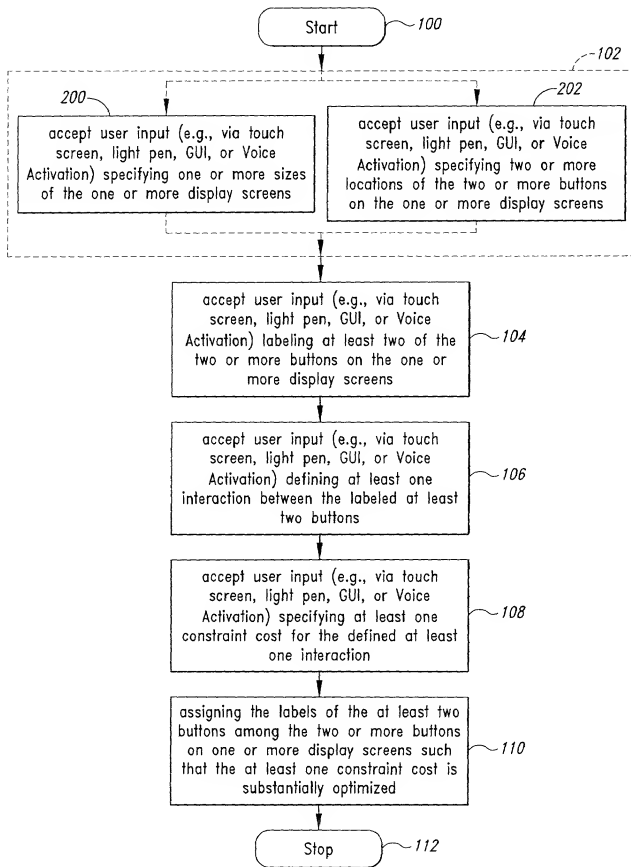
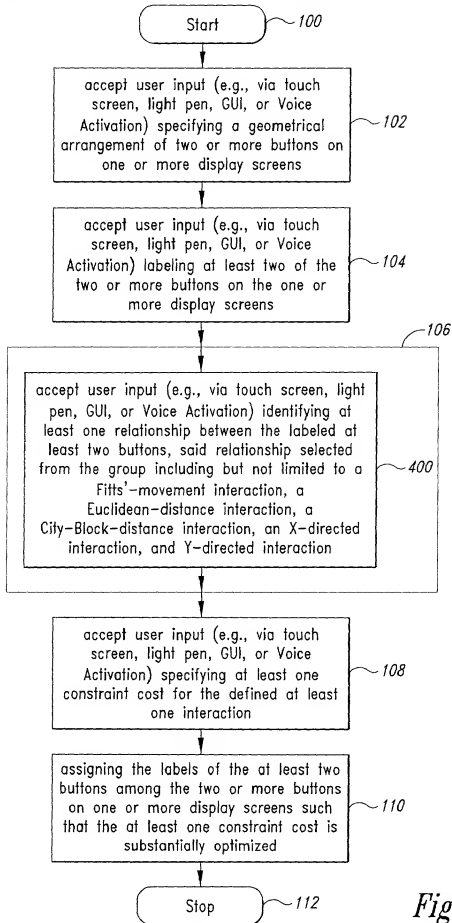
*Fig. 1*

*Fig. 2*



*Fig. 4*

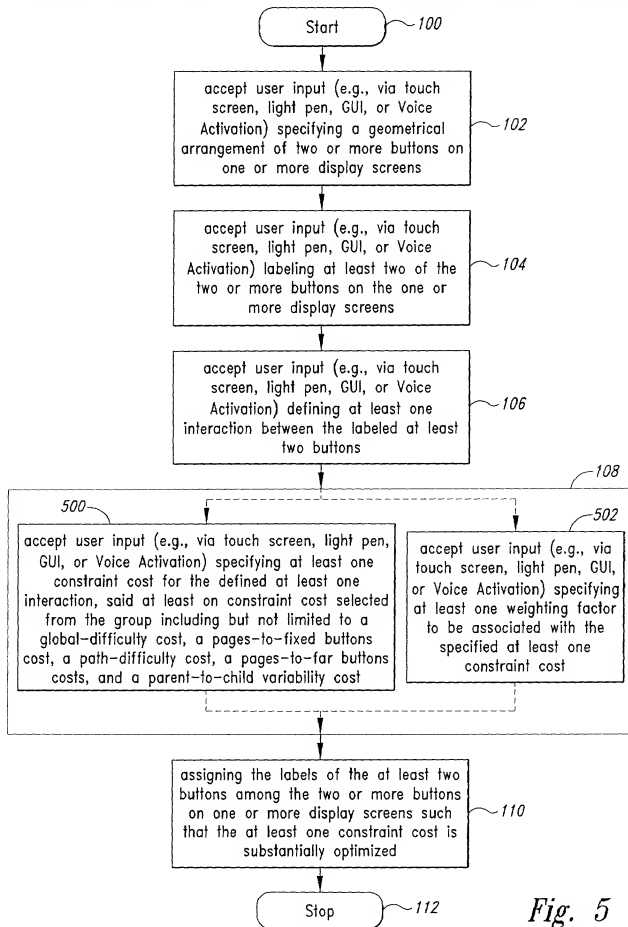


Fig. 5

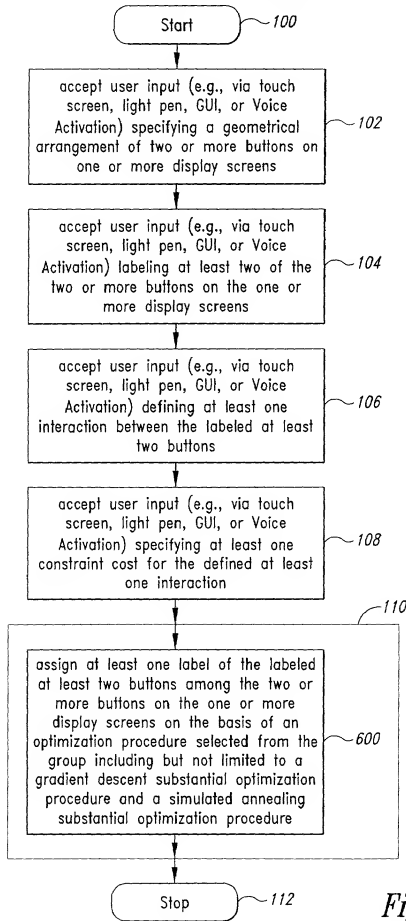


Fig. 6

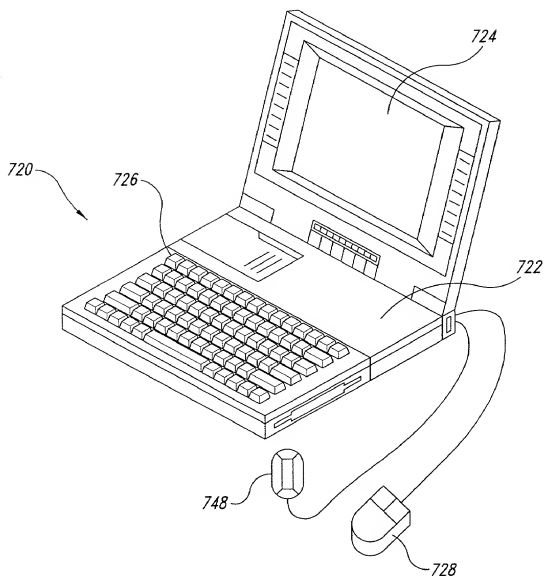
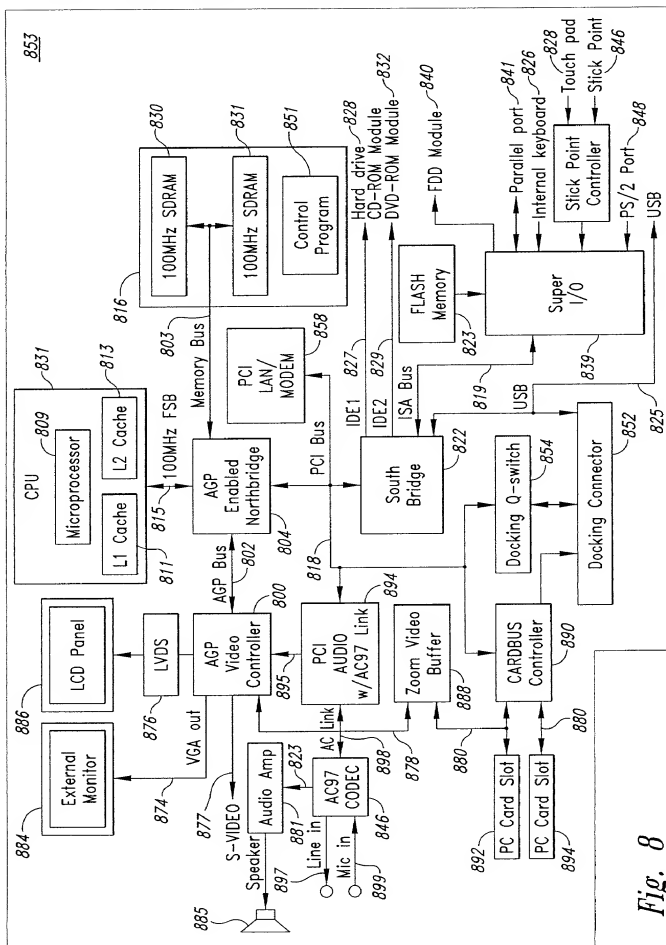
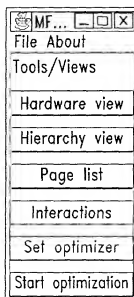


Fig. 7





The MFDTool startup window, as seen in Windows 98.

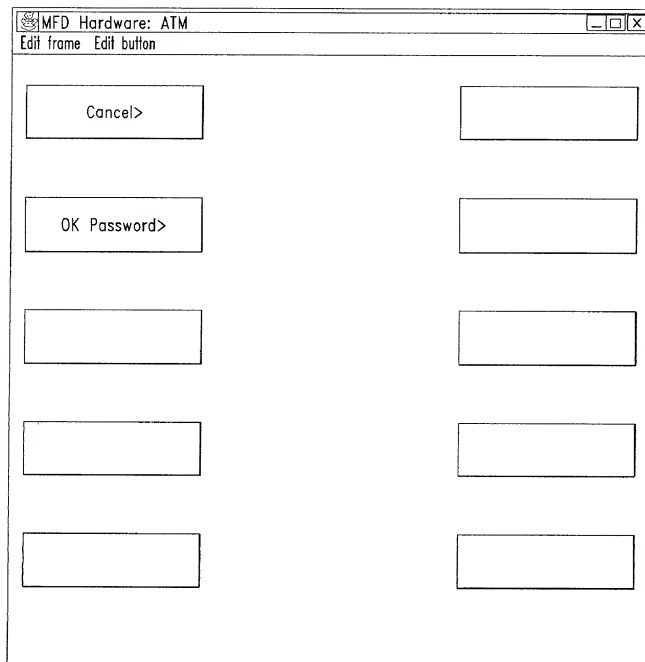
Fig. 9

```

ATM & Name
6 6 & xSize, ySize
%Buttons
1.5 0.5 0.1 0.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 0.1 1.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 0.1 2.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 0.1 3.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 0.1 4.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 4.4 0.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 4.4 1.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 4.4 2.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 4.4 3.25 & xSize, ySize, xPlace, yPlace
1.5 0.5 4.4 4.25 & xSize, ySize, xPlace, yPlace
&&
    
```

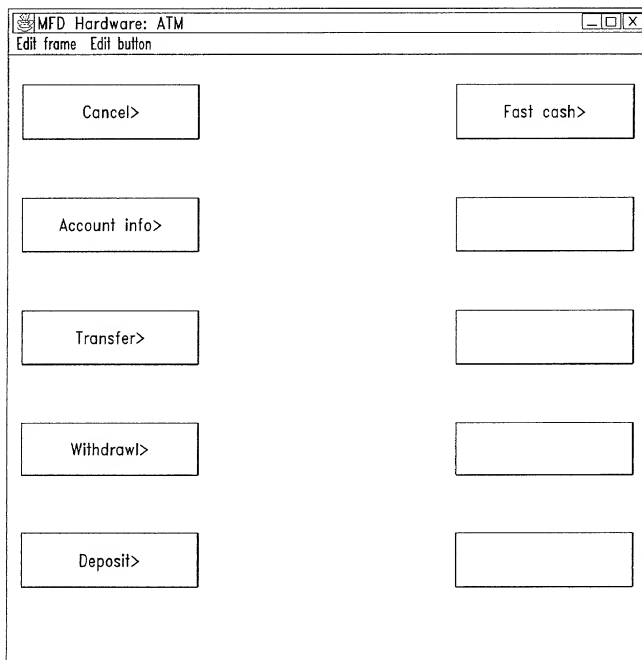
Contents of the file ATM.hdw, which defines the size of the MFD and the physical properties of the buttons for the ATM example.

Fig. 10



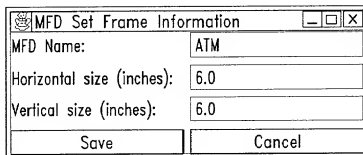
The MFD Hardware window shows the physical layout of the MFD and its buttons, as specified in the file ATM.hdw.

Fig. 11



The MFD Hardware window after selecting the OK Password label show the labels on the selected page.

Fig. 12

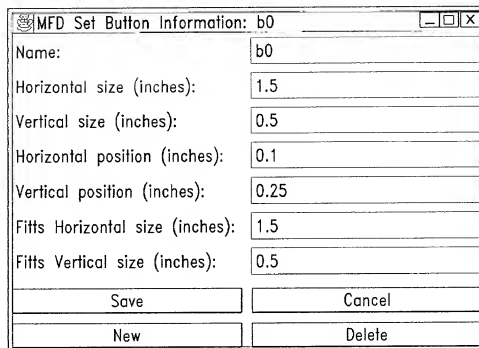


A screenshot of a software dialog box titled "MFD Set Frame Information". It contains three input fields: "MFD Name:" with the value "ATM", "Horizontal size (inches):" with the value "6.0", and "Vertical size (inches):" with the value "6.0". At the bottom are two buttons: "Save" and "Cancel".

MFD Set Frame Information	
MFD Name:	ATM
Horizontal size (inches):	6.0
Vertical size (inches):	6.0
Save	Cancel

The MFD Set Frame Information window allows the designer to modify the name of the MFD and set the size of the MFD frame.

Fig. 13

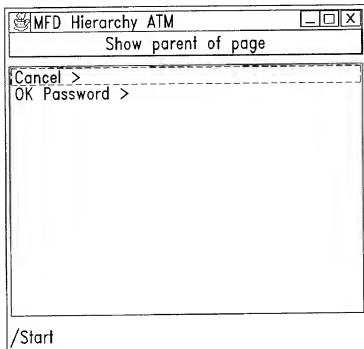


A screenshot of a software dialog box titled "MFD Set Button Information: b0". It contains seven input fields: "Name:" with "b0", "Horizontal size (inches):" with "1.5", "Vertical size (inches):" with "0.5", "Horizontal position (inches):" with "0.1", "Vertical position (inches):" with "0.25", "Fitts Horizontal size (inches):" with "1.5", and "Fitts Vertical size (inches):" with "0.5". At the bottom are four buttons: "Save", "Cancel", "New", and "Delete".

MFD Set Button Information: b0	
Name:	b0
Horizontal size (inches):	1.5
Vertical size (inches):	0.5
Horizontal position (inches):	0.1
Vertical position (inches):	0.25
Fitts Horizontal size (inches):	1.5
Fitts Vertical size (inches):	0.5
Save	Cancel
New	Delete

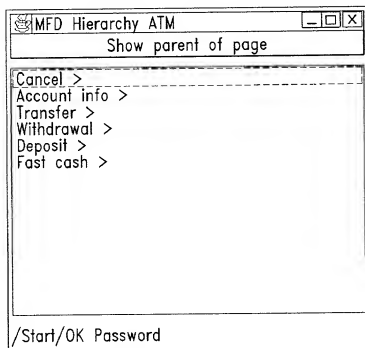
The MFD Set Button Information window allows the designer to modify button properties, delete a button, and create a new button.

Fig. 14



The MFD Hierarchy window as it appears after opening the file ATM.hdw.

Fig. 15



The MFD Hierarchy window as it appears after selecting the page name OK Password.

Fig. 16

MFD Page list: ATM

Page properties

Button assignment Name: Start

b0 Proportion: 0.02380952380952: ☒ Free ☐ Fixed

b1 Page type: Parent

b2 Parent Start

b3 Hyperlink No hyperlink required

b4

Swap to clicked button

Save Duplicate New Delete Cancel

Sort page listing by

Name	Page type	Proportion
CheckingToSavings	T	0.023809524
CreditCard	P	0.023809524
Deposit	P	0.023809524
Exit	T	0.023809524
Fast cash	P	0.023809524
Loans	P	0.023809524
Mortgage	T	0.023809524
NewTransaction	H-	0.023809524
OK Password	P	0.023809524
Personal	T	0.023809524
RecentTransactions	T	0.023809524
RecentTransactions	T	0.023809524
RecentTransactions	T	0.023809524
Savings	P	0.023809524
Savings	T	0.023809524
Savings	T	0.023809524
SavingsToChecking	T	0.023809524
Start	P	0.023809524
Transfer	P	0.023809524
Withdrawal	P	0.023809524

The MFD Page list window as it appears after opening the file ATM.hdw.

Fig. 17

MFD Page list: ATM

Page properties

Button assignment Name:

b0 ☐ Proportion: ☒ Free ☐ Fixed

b1 ☒ Page type:

b2 ☐ Start

b3 ☐ No hyperlink required

b4 ☐

Swap to clicked button

Sort page listing by

Name	Page type	Proportion
CheckingToSavings	T	0.023809524
CreditCard	P	0.023809524
Deposit	P	0.023809524
Exit	T	0.023809524
Fast cash	P	0.023809524
Loans	P	0.023809524
Mortgage	T	0.023809524
NewTransaction	H-	0.023809524
OK Password	P	0.023809524
Personal	T	0.023809524
RecentTransactions	T	0.023809524
RecentTransactions	T	0.023809524
RecentTransactions	T	0.023809524
Savings	P	0.023809524
Savings	T	0.023809524
Savings	T	0.023809524
SavingsToChecking	T	0.023809524
Start	P	0.023809524
Transfer	P	0.023809524
Withdrawal	P	0.023809524

The MFD Page list window as it appears after selecting the page name OK Password.

Fig. 18

MFD Page list: ATM

Page properties

Button assignment Name:

Left top ☒ Proportion: ☒ Free ☐ Fixed

Left 2 ☐ Page type:

Left 3 ☐ OK Password

Left 4 ☐ No hyperlink required

Swap to clicked button

Sort page listing by

Name	Page type	Proportion
\$10	T	0.023809524
\$20	T	0.023809524
\$50	T	0.023809524
Account info	P	0.023809524
AccountBalance	T	0.023809524
AccountBalance	T	0.023809524
Balance	T	0.023809524
Cancel	P	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Cancel	H-	0.023809524
Car	T	0.023809524
Checking	P	0.023809524
Checking	T	0.023809524

The MFD Page list window as it appears after selecting the page Cancel.

Fig. 19

MFD Set Interactions: ATM

Select interaction

Initial interaction

Name

Initial interaction

Delete interaction Duplicate interaction

New interaction Save interaction

Set constraints

Interface coefficients Load pre-defined coefficients Fitts movement

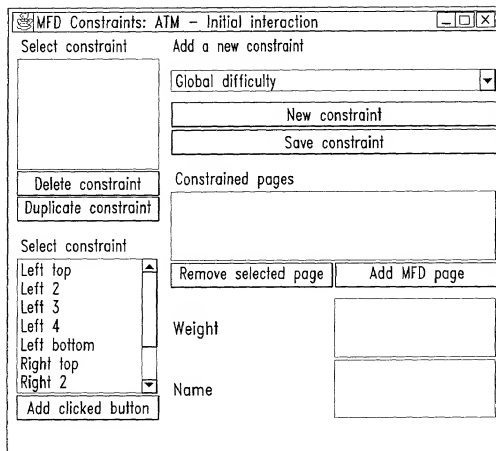
From -- To	Left top	Left 2	Left 3	Left 4
Left top	0.0	0.0	0.0	0.0
Left 2	0.0	0.0	0.0	0.0
Left 3	0.0	0.0	0.0	0.0
Left 4	0.0	0.0	0.0	0.0
Left bottom	0.0	0.0	0.0	0.0
Right top	0.0	0.0	0.0	0.0
Right 2	0.0	0.0	0.0	0.0
Right 3	0.0	0.0	0.0	0.0
Right 4	0.0	0.0	0.0	0.0

Interaction opened

The MFD Set Interactions window as it appears after selecting the Initial interactions.

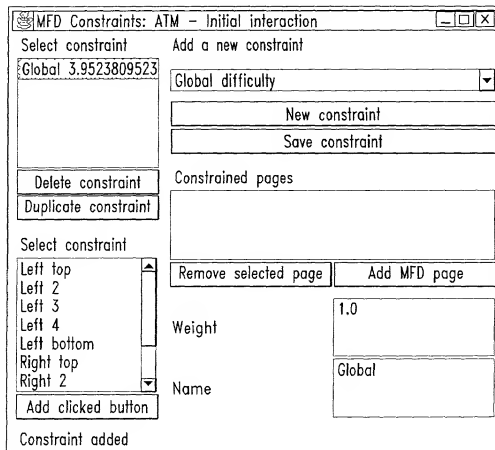
Fig. 20

Fig. 21



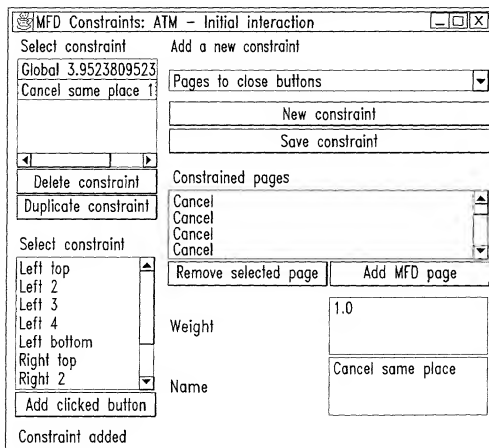
The MFD Constraints: ATM - Initial interaction window when it first appears.

Fig. 22



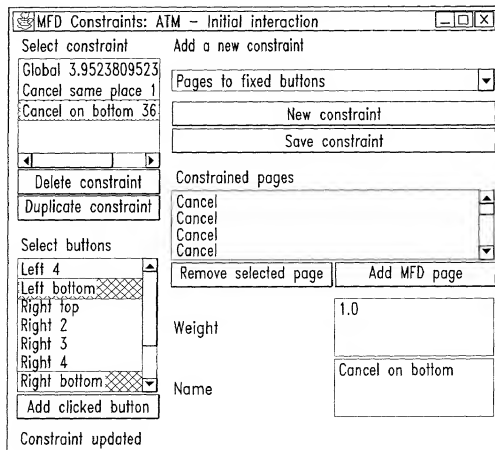
The MFDTool window as it appears after creating and saving the constraint Global.

Fig. 23



The MFD Constraint window as it appears after creating and saving the constraint Cancel same place. The list Constrained pages shows all the pages restricted by this constraint.

Fig. 24



The MFD Constraints window as it appears after creating and saving the constraint Cancel on bottom. The list Constrained pages shows all the pages restricted by this constraint. The list Select buttons shows the buttons that the constrained pages must be restricted to.

Fig. 25

MFD Constraints: ATM - Initial interaction

Select constraint Add a new constraint

Global 3.9523809523
 Cancel same place 1
 Cancel on bottom 36
 Cancel ->NewTransaction

Path difficulty

New constraint

Save constraint

Constrained pages

Cancel
 NewTransaction

Remove selected page Add MFD page

Weight 100.0

Name ncel ->NewTransaction

Select buttons

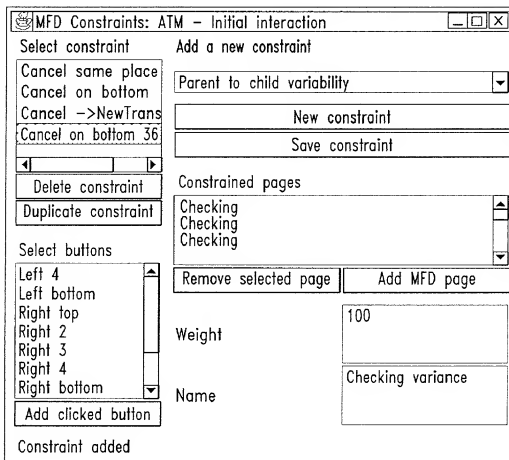
Left 4
 Left bottom
 Right top
 Right 2
 Right 3
 Right 4
 Right bottom

Add clicked button

Constraint added

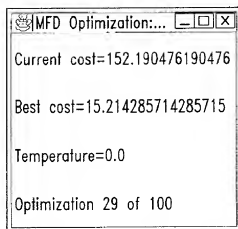
The MFD Constraints window as it appears after creating and saving the constraint Cancel -> New Transaction. The list Constrained pages shows the path of pages restricted by this constraint. In this case, the path starts at the Cancel hyperlink under Fast cash and goes to the New Transaction page under the Cancel page near the top of the hierarchy. MFDTool will assign page labels to buttons so that the sum of interaction coefficients is minimized along this path of pages.

Fig. 26



The MFD Constraints window as it appears after creating and saving the constraint Checking variance. The list of Constrained pages shows all the pages restricted by this constraint.

Fig. 27



The MFD Optimization window as it appears while running an optimization.

Fig. 28

MFD Constraints: ATM - Initial interaction

Select constraint

Global 2.8571428571428563
 Cancel same place 0.0
 Cancel on bottom 0.0
 Cancel ->NewTransaction 0.0
 Checking variance 0.0

Delete constraint
 Duplicate constraint

Select buttons

Left top
 Left 2
 Left 3
 Left 4
 Left bottom
 Right top
 Right 2

Add clicked button

Add a new constraint

Global difficulty

New constraint
 Save constraint

Constrained pages

Remove selected page
 Add MFD page

Weight

Name

The MFD Constraints window as it appears after the optimization. The cost for all but the Global is zero, indicating that these constraints are perfectly satisfied.

Fig. 29

100260 6901660

MFD Set Button Information: b0

File

Number of optimizer: ☒ Gradient descent ☐ Simulated annealing

Number of swaps per cycle: 300

Number of initialization cycles (bigger is more random): 200

Number of cycles unchanged before checking on local minimum: 10

Number of random restarts of gradient descent: 200

Simulated annealing start temperature: 0.0

Simulated annealing temperature multiplier ($0 < x < 1$): 0.9900000009537432

Save parameters

The MFD Set Optimizer window.

Fig. 30